

Claims

What is claimed is:

1. I method of frequency modification for one or more electronic components
5 in an electronic system, the method comprising the steps of:
determining, at a particular age of the electronic system, one or more
performance parameters for the electronic system, the one or more performance
parameters correlated with maximum operating frequency of one or more electronic
components of the electronic system for the particular age of the electronic system; and
10 adjusting an operating frequency of the one or more electronic components
from the electronic system in accordance with the one or more performance parameters.
2. The method of claim 1, wherein the step of adjusting adjusts the operating
frequency to an adjusted operating frequency, and wherein the adjusted operating
15 frequency is less than or equal to the maximum operating frequency of the one or more
electronic components for the particular age of the system.
3. The method of claim 1, wherein a given one of the one or more
performance parameters can be converted to a selected operating frequency to be used in
20 the step of adjusting.
4. The method of claim 3, wherein the given performance parameter
comprises a multiplicand used to convert a base frequency to the selected operating
frequency to be used in the step of adjusting.
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5. The method of claim 1, wherein the step of determining a performance
parameter further comprises the steps of determining whether the particular age of the
electronic system is a predetermined age, and determining an operating frequency from
the one or more performance parameters when the particular age is the given age.

6. The method of claim 5, wherein a given one of the one or more performance parameters comprises a predetermined operating frequency to be used in the steps of determining and adjusting.

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7. The method of claim 1, wherein the step of determining, at a particular age of the electronic system, a performance parameter for the electronic system, further comprises the step of gathering, at the particular age of the electronic system, performance statistics from one or more feedback circuits, and determining whether
10 actual performance of the electronic system should be adjusted by using the performance statistics.

8. The method of claim 7, wherein the step of gathering, at the particular age of the electronic system, performance statistics from one or more feedback circuits,
15 further comprises the step of gathering, at the particular age of the electronic system, performance statistics from one or more age-monitoring circuits.

9. The method of claim 8, wherein the step of gathering, at the particular age of the electronic system, performance statistics from one or more age-monitoring circuits
20 further comprises the step of determining, at the particular age of the electronic system, a given performance statistic by comparing speed of an aged circuit with speed of a test circuit that is enabled only for the comparison, wherein the aged circuit has been operated for approximately the particular age.

25 10. The method of claim 7, wherein the step of gathering, at the particular age of the electronic system, performance statistics from one or more feedback circuits, further comprises the step of gathering, at the particular age of the electronic system, performance statistics from one or more error detecting circuits.

11. The method of claim 10, wherein:
the step of gathering further comprises the step of determining that one or more errors have occurred; and
the step of adjusting an operating frequency further comprises the steps of
5 lowering operating frequency from a current operating frequency, beginning execution at a point before the one or more errors occurred, determining if the one or more errors reoccur, and if the one or more errors do not reoccur, leaving the lowered operating frequency as the current operating frequency.
- 10 12. The method of claim 11, wherein the step of adjusting further comprises, before the step of lowering operating frequency, the steps of beginning execution at a point before the one or more errors occurred, determining if the one or more errors reoccur, and if the one or more errors do not reoccur, leaving current operating frequency alone.
- 15 13. The method of claim 1, wherein the one or more performance parameters comprise one or more of previous operating frequency, ambient temperature, hours of operation, and supply voltage.
- 20 14. The method of claim 1, wherein the one or more performance parameters are stored performance parameters and wherein the method further comprises the step performing reliability testing to determine wear-out information comprising the stored performance parameters.
- 25 15. The method of claim 14, wherein the stored performance parameters comprise predetermined ages and predetermined operating frequencies at corresponding ones of the predetermined ages.

16. The method of claim 14, wherein the step of performing reliability testing further comprises the step of determining one or more prior operating frequencies of the electronic system, one or more ambient temperatures surrounding the electronic system, and one or more supply voltages of the electronic system.
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17. The method of claim 16, further comprising the step of providing supply voltage for the electronic system that is higher than nominal supply voltage.
18. The method of claim 16, further comprising the step of providing ambient
10 temperature surrounding the electronic system that is higher than nominal ambient temperature.
19. The method of claim 1, wherein the performance parameters are received from an external source.
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20. An electronic system able to perform frequency modification for electronic components, the electronic system comprising:
one or more electronic components;
at least one clock generation circuit coupled to the one or more electronic
20 components and adapted to:
determine, at a particular age of the electronic system, one
or more performance parameters for the electronic system, the one or more
performance parameters correlated with maximum operating frequency of
one or more electronic components of the electronic system for the
25 particular age of the electronic system; and
adjust an operating frequency of the one or more electronic
components from the electronic system in accordance with the one or more
performance parameters.

21. The electronic system of claim 20, wherein:
the performance parameters comprise a plurality of predetermined ages
and a corresponding plurality of predetermined operating frequencies;
the at least one clock generation circuit comprises a wear-out clock;

5 the wear-out clock is adapted to determine, at a particular age of the
electronic system, one or more of the predetermined ages and to determine whether a
current age of the electronic system corresponds to a given one of the predetermined ages;
and

the wear-out clock is further adapted to adjust operating frequency of the
10 one or more electronic components by adjusting a current operating frequency of the one
or more electronic components to a predetermined operating frequency corresponding to
the given predetermined age.

22. The electronic system of claim 21, wherein the wear-out clock is further
15 adapted to retrieve the predetermined ages and corresponding predetermined operating
frequencies from a source external to the wear-out clock.

23. The electronic system of claim 20, wherein the at least one clock
generation circuit further comprises a performance control unit.

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24. The electronic system of claim 23, further comprising one or more
feedback circuits in the one or more electronic components, the one or more feedback
circuits coupled to the performance control unit.

25 25. The electronic system of claim 24, wherein a given one of the one or more
performance parameters comprises one or more performance statistics, wherein a given
one of the feedback circuits comprises an age-monitoring circuit comprising an aged
circuit and a new circuit, wherein the performance control unit is adapted to enable the
new circuit only during a comparison between the aged and new circuits and to determine

the one or more performance statistics from the comparison, wherein the aged circuit has been operated for approximately the particular age.

26. The electronic system of claim 24, wherein:

5 a given one of the one or more performance parameters comprises one or more performance statistics;

a given one of the feedback circuits comprises an error detecting circuit, the error detecting circuit adapted to determine if an error occurs, wherein the one or more performance statistics indicate that an error has occurred;

10 the performance control unit is further adapted to receive the one or more performance statistics, indicating that one or more errors have occurred, from the error detection circuit, to lower operating frequency from a current operating frequency, to cause execution to begin at a point before the one or more errors occurred, to determine if the error reoccurs, and if the error does not reoccur, to leave the lowered operating
15 frequency as the current operating frequency.

27. The electronic system of claim 20, wherein the at least one clock generation circuit further comprises an oscillator and one or more frequency multipliers, the oscillator having an output, each of the one or more of the frequency multipliers
20 having an input and output, the output of the oscillator coupled to an input of each of the one or more frequency multipliers, a given one of the one or more electronic components coupled to an output of a given one of the one or more frequency multipliers, and wherein the at least one clock generation circuit is further adapted to create an adjusted operating frequency for the given electronic component by adjusting one or more of the following:
25 operating frequency of the oscillator and a multiplicand used in the given frequency multiplier.

28. An article of manufacture for performing frequency modification for electronic components, the article of manufacture comprising:

 a computer readable medium containing one or more programs which when executed implement the steps of:

- 5 determining, at a particular age of the electronic system, one or more performance parameters for the electronic system, the one or more performance parameters correlated with maximum operating frequency of one or more electronic components of the electronic system for the particular age of the electronic system; and
- adjusting an operating frequency of the one or more electronic components
- 10 from the electronic system in accordance with the one or more performance parameters.